

Water Heating Subcommittee Meeting #5



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MEETING #5

Water Heating

2

- Issues for further discussion
 - 6.10 - Process Boiler savings – best available data
 - 6.18a - Demand Control for central water heaters recirc pump – Methodology and cost updates
 - 6.19 - DHW Loop Temp Control, MFm – Methodology
 - Various: MFm – Com vs Res
 - ✦ Should it effect EUL and NTGR
 - ✦ Does this need to be a Stage 2 issue?

6.10 - Process Boiler

3

- Best available data for process boiler hours of operation
- PGECOPRO101, R5
 - ❑ Data from the analysis of industrial and commercial boilers was combined with industry-specific Gross Domestic Product (GDP) data to get an accurate estimation of the average process boiler capacity factor in California.
 - ❑ $EFLH = 8,760 \text{ hrs/yr} * 41.9\% = 3,670 \text{ hrs/yr}$ (weighted average)

Industry	Capacity Factor	Number of Boilers	% of CA industry GDP vs nationwide industry GDP	Estimated number of boilers per industry in CA	Weighting factor
Food	0.31	10,610	9.70%	1,030	25.7%
Paper	0.66	3,460	4.30%	150	3.7%
Chemicals	0.50	11,980	8.80%	1,050	26.2%
Refining	0.25	1,200	21.50%	260	6.5%
Metals	0.47	3,330	4.50%	150	3.7%
Other Manufacturing	0.44	12,435	11.05%	1,370	34.2%
Totals		43,015		4,010	100.0%
Average Capacity Factor	0.419				

- Capacity Data from Oak Ridge National Lab study (2005)
- Weighting data taken US DOC (2008)

6.10 - Process Boiler

4

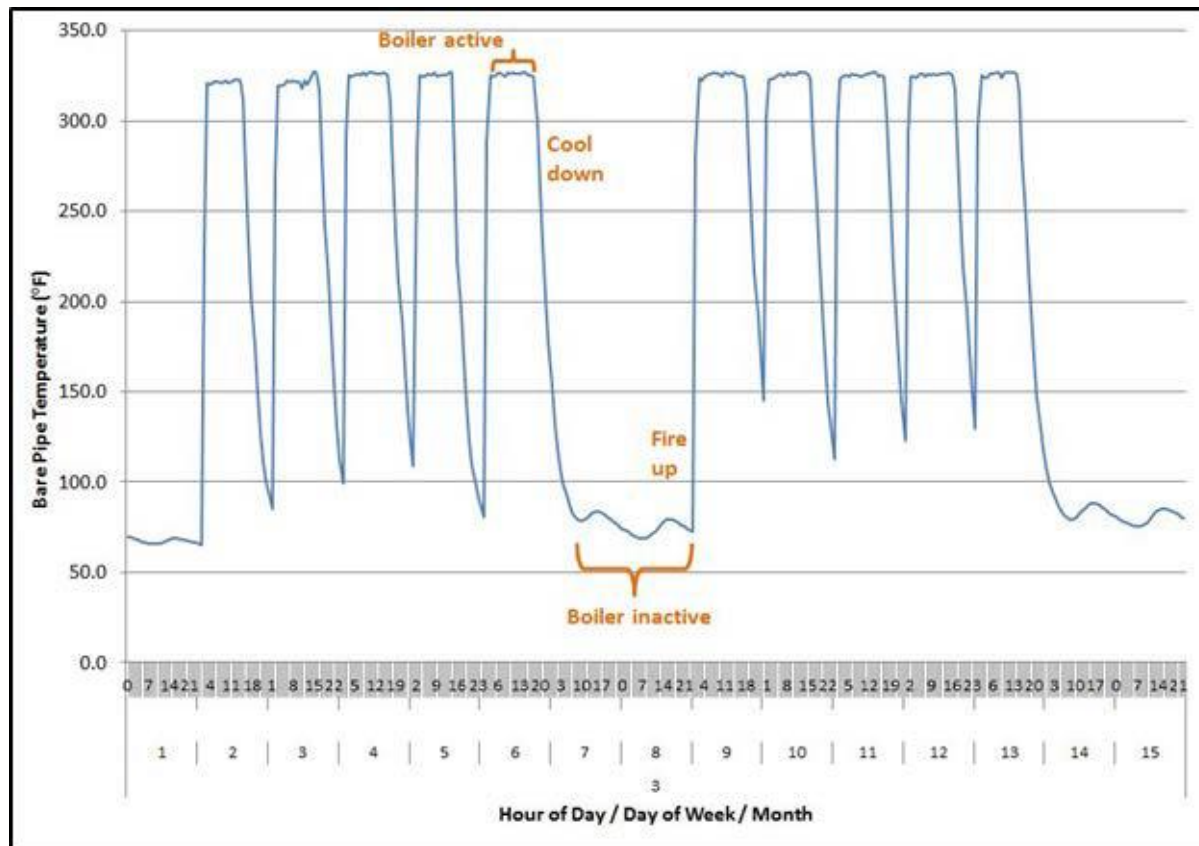
- Best available data for process boiler hours of operation
- WPSCGWP110812A, Rev 4 (Pipe and Fitting Insulation Measure)
 - **Itron: 2014 Nonresidential Downstream Deemed ESPI Pipe Insulation Impact Evaluation Report**
 - ✦ The following parameters were updated and taken from the ESPI study; **operating hours**, NTG, GRR, pipe surface temperature, ambient air temperature and boiler efficiency. The ESPI study was performed by Itron and prepared for the CPUC to perform an impact evaluation on the deemed savings and measure-parameter associated with pipe insulation measures.

Sector	Operating Hours
Small Commercial	7,003
Large Commercial	6,056
Industrial	6,333

6.10 - Process Boiler- Evaluation Input

5

- 2015 ESPI Report
- 2014 Deemed ESPI Report



6.10 - Process Boiler- 2015 ESPI Report

6

- 2015 ESPI Report

TABLE 4-2: COMPARISON OF EX ANTE AND EX POST ANNUAL OPERATING HOURS BY CUSTOMER TYPE

Customer Type	Sites	Observations [†]	Ex Ante Operating Hours	Mean Ex Post Operating Hours	Ex Post Standard Deviation (Hours)
Small Commercial	3	6	2,425	7,003	2,495
Large Commercial	8	17	4,380	6,552	3,125
Industrial	8	27	7,752	6,106	2,648

- 2014 Deemed ESPI Report

Customer Type	Sites	Observations	Ex Ante Operating Hours	Ex Post Operating Hours
Small Commercial*	0	0	2,425	N/A
Large Commercial	11	33	4,380	5,560
Industrial	20	60	7,752	6,560

- Average hours for industrial $(6,560 + 6,106)/2 = 6,333$ hrs/yr

6.18a - Demand Control for Central Water Heaters - Methodology

7

Workpaper	Old ODE MF Workpaper	New Multifamily Recirc Pump Control Workpaper	New Commercial Recirc Pump Control Workpaper (Campus Housing)
Baseline consumption	Baseline consumption taken from measurements of a specific subset of buildings; small sample size	Baseline consumption taken from DEER models that take into account building information and characteristics of the entire sector (operation hours, load shapes, etc, # recirc loops, floor area).	Baseline consumption taken from DEER models that take into account building information and characteristics of the entire sector (operation hours, load shapes, etc, # recirc loops, floor area). Baseline consumption in these models is less than what is estimated consumption in the field
Savings basis	Savings calculated from measuring boiler operation hours (on and off times) <ul style="list-style-type: none"> Decreased pump run time Decreased water heater run time 	Savings derived from DEER eQUEST models (preferred methodology of the Energy Division); estimates difference in energy consumption from maintaining lower loop temperature thus less heat loss in recirculation loop	Savings derived from DEER eQUEST models (preferred methodology of the Energy Division); estimates difference in energy consumption from maintaining lower loop temperature thus less heat loss in recirculation loop
Building characteristics	Differentiates savings between high rise (3+ floors) and low rise (up to 3 floors) <ul style="list-style-type: none"> Low rise: 23 therms/dwelling High rise: 14 therms/dwelling 	No differentiation between high and low rise. Building size and unit size are important variables (correlate to size of recirculation loop). Model representative of 4 story, 24 dwelling unit building (Average floor area per unit = 1200 sq. ft) <ul style="list-style-type: none"> 13.54 therms/dwelling 	Building size and unit size are important variables that were refined using Benningfield campus housing data and DEER model numbers (Average floor area per unit = 511 sq. ft) <ul style="list-style-type: none"> 5.73 therms/dwelling
Technology	Only includes on/off technology	Includes on/off, VFD, and other technologies that use hot water loop temperature as a single-controlled variable	Includes on/off, VFD, and other technologies that use hot water loop temperature as a single-controlled variable

6.18a - Demand Control for Central Water Heaters - Cost

8

- PGECODHW126, R2

Measure Description	MeasAppType	Base Case Cost (\$/unit)	MatlCost (\$/unit)	LaborCost (\$/unit)	Incremental/Full Measure Cost (\$/unit)
DEMD CNTL RECIRC PMP GAS CENTR WATER HEATER LR 5 UNITS	REA	\$ -	\$ 1,632.40	\$ 117.92	\$ 1,750.32
DEMD CNTL RECIRC PMP GAS CENTR WATER HEATER HR 20 UNITS	REA	\$ -	\$ 1,632.40	\$ 117.92	\$ 1,750.32
DEMD CNTL RECIRC PMP GAS CENTR WATER HEATER LR 10 UNITS	REA	\$ -	\$ 1,632.40	\$ 117.92	\$ 1,750.32
DEMD CNTL RECIRC PMP GAS CENTR WATER HEATER HR 25 UNITS	REA	\$ -	\$ 1,632.40	\$ 117.92	\$ 1,750.32
DEMD CNTL RECIRC PMP GAS CENTR WATER HEATER LR 15 UNITS	REA	\$ -	\$ 1,632.40	\$ 117.92	\$ 1,750.32
DEMD CNTL RECIRC PMP GAS CENTR WATER HEATER HR 30 UNITS	REA	\$ -	\$ 1,632.40	\$ 117.92	\$ 1,750.32
DEMD CNTL RECIRC PMP GAS CENTR WATER HEATER LR 20 UNITS	REA	\$ -	\$ 1,632.40	\$ 117.92	\$ 1,750.32
DEMD CNTL RECIRC PMP GAS CENTR WATER HEATER HR 35 UNITS	REA	\$ -	\$ 1,632.40	\$ 117.92	\$ 1,750.32
DEMD CNTL RECIRC PMP GAS CENTR WATER HEATER LR 25 UNITS	REA	\$ -	\$ 1,632.40	\$ 117.92	\$ 1,750.32
DEMD CNTL RECIRC PMP GAS CENTR WATER HEATER HR 40 UNITS	REA	\$ -	\$ 1,632.40	\$ 117.92	\$ 1,750.32
DEMD CNTL RECIRC PMP GAS CENTR WATER HEATER LR 30 UNITS	REA	\$ -	\$ 1,632.40	\$ 117.92	\$ 1,750.32
DEMD CNTL RECIRC PMP GAS CENTR WATER HEATER HR 45 UNITS	REA	\$ -	\$ 1,632.40	\$ 117.92	\$ 1,750.32
DEMD CNTL RECIRC PMP GAS CENTR WATER HEATER LR 35 UNITS	REA	\$ -	\$ 1,632.40	\$ 117.92	\$ 1,750.32
DEMD CNTL RECIRC PMP GAS CENTR WATER HEATER HR 50 UNITS	REA	\$ -	\$ 1,632.40	\$ 117.92	\$ 1,750.32
DEMD CNTL RECIRC PMP GAS CENTR WATER HEATER LR 40 UNITS	REA	\$ -	\$ 1,632.40	\$ 117.92	\$ 1,750.32

- Same cost – per building
 - Based upon current product quotes from vendor

6.18a - Demand Control for Central Water Heaters - Cost

9

- Installation Type: ~~REA~~ or AR ~~/NR~~
 - Was there feedback that this pump is replaced rather than retrofit?

Measure Description	MeasAppType	Norm Unit	Base Case Cost (\$/unit)	MatlCost (\$/unit)	LaborCost (\$/unit)	Incremental/Full Measure Cost (\$/unit)
5 Units	REA or ROB/ER	Dwelling		\$ 326.48	\$ 23.58	\$ 350.06
10 Units	REA or ROB/ER	Dwelling		\$ 163.24	\$ 11.79	\$ 175.03
15 Units	REA or ROB/ER	Dwelling		\$ 108.83	\$ 7.86	\$ 116.69
20 Units	REA or ROB/ER	Dwelling		\$ 81.62	\$ 5.90	\$ 87.52
25 Units	REA or ROB/ER	Dwelling		\$ 65.30	\$ 4.72	\$ 70.01
30 Units	REA or ROB/ER	Dwelling		\$ 54.41	\$ 3.93	\$ 58.34
35 Units	REA or ROB/ER	Dwelling		\$ 46.64	\$ 3.37	\$ 50.01
40 Units	REA or ROB/ER	Dwelling		\$ 40.81	\$ 2.95	\$ 43.76
45 Units	REA or ROB/ER	Dwelling		\$ 36.28	\$ 2.62	\$ 38.90
50 Units	REA or ROB/ER	Dwelling		\$ 32.65	\$ 2.36	\$ 35.01

6.19 - DHW Loop Temp Control, MFm

10

- 6.19 - DHW Loop Temp Control, MFm – Methodology
 - PGECODHW115, R3

Input Variables for Energy Savings Estimates in Multifamily Facilities	“No Control” Base Case Values	HA10 “Temperature Modulation” Boiler Controller Values
Avg. thermal efficiency for the gas hot water supply boiler or large gas storage water heater in the central water heating system	80% thermal efficiency	80% thermal efficiency
Avg. therms/multifamily dwelling unit/yr Unit Energy Consumption (UEC) for the “no control” base case	186 therms	N/A
Avg. water heating gas consumption for supply & return water piping heat losses	30%	30%
Avg. supply water temperature	135 deg. F	132.5 deg. F
Avg. lower supply & return water piping temperature than supply water temperature	5 deg. F	5 deg. F
Avg. supply & return water piping surroundings temperature	60 deg. F	60 deg. F

6.19 - DHW Loop Temp Control, MFm

11

- 6.19 - DHW Loop Temp Control, MFm – Methodology
 - SCGWP100315A, Rev1

Table 2: DHW Draw Profile

Hourly Demand Profile						
Hour	Typical Weekday		Typical Saturday		Typical Sunday	
	Load (%)	time fired (min)	Load (%)	time fired (min)	Load (%)	time fired (min)
Mdnt - 1 AM	5.00	3.00	8.04	4.82	8.06	4.84
1 - 2 AM	5.00	3.00	5.36	3.22	5.37	3.22
2 - 3 AM	5.00	3.00	5.00	3.00	5.00	3.00
3 - 4 AM	5.00	3.00	5.00	3.00	5.00	3.00
4 - 5 AM	5.00	3.00	5.00	3.00	5.00	3.00
5 - 6 AM	20.00	12.00	5.00	3.00	5.00	3.00
6 - 7 AM	80.00	48.00	5.73	3.44	5.00	3.00
7 - 8 AM	70.25	42.15	11.54	6.92	5.36	3.22
8 - 9 AM	50.00	30.00	26.63	15.98	8.92	5.35
9 - 10 AM	40.25	24.15	46.51	27.91	19.56	11.74
10 - 11 AM	20.00	12.00	47.14	28.28	26.91	16.15
11 - Noon	20.00	12.00	32.56	19.54	22.74	13.64
Noon - 1PM	20.00	12.00	31.55	18.93	30.26	18.16
1 - 2 PM	29.75	17.85	46.81	28.09	43.32	25.99
2 - 3 PM	50.00	30.00	75.51	45.31	56.75	34.05
3 - 4 PM	50.00	30.00	71.54	42.92	64.55	38.73
4 - 5 PM	70.25	42.15	68.71	41.23	46.94	28.16
5 - 6 PM	70.25	42.15	63.08	37.85	33.68	20.21
6 - 7 PM	40.25	24.15	55.11	33.07	25.32	15.19
7 - 8 PM	40.25	24.15	46.65	27.99	20.65	12.39
8 - 9 PM	20.00	12.00	38.15	22.89	19.95	11.97
9 - 10 PM	20.00	12.00	29.75	17.85	19.95	11.97
10 - 11 PM	10.25	6.15	21.78	13.07	19.02	11.41
11 - Mdnt	10.25	6.15	13.84	8.30	13.54	8.12
	31.5%	454.1 minutes	31.9%	459.6 minutes	21.5%	309.5 minutes
	7.57 hrs/day		7.66 hrs/day		5.16 hrs/day	
	37.84 hrs/wk		7.66 hrs/wk		5.16 hrs/wk	
	50.7 hrs/wk					
	Annual EFLH = 2641 hrs/yr					